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EPA

Engineering Bulletin
In Situ Soil Vapor Extraction Treatment

Purpose

Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandates the Environmental Protection Agency (EPA) to select remedies that "utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable" and to prefer remedial actions in which treatment "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants as a principal element." The Engineering Bulletins are a series of documents that summarize the latest information available on selected treatment and site remediation technologies and related issues. They provide summaries of and references for the latest information to help remedial project managers, on-scene coordinators, contractors, and other site cleanup managers understand the type of data and site characteristics needed to evaluate a technology for potential applicability to their Superfund or other hazardous waste site. Those documents that describe individual treatment technologies focus on remedial scoping needs. Addenda will be issued periodically to update the original bulletins.

Abstract

Soil vapor extraction (SVE) is designed to physically remove volatile compounds, generally from the vadose or unsaturated zone. It is an in situ process employing vapor extraction wells alone or in combination with air injection wells. Vacuum blowers supply the motive force, inducing air flow through the soil matrix. The air strips the volatile compounds from the soil and carries them to the screened extraction well.

Air emissions from the systems are typically controlled by adsorption of the volatiles onto activated carbon, thermal destruction (incineration or catalytic oxidation), or condensation by refrigeration [1, p. 26].*

SVE is a developed technology that has been used in commercial operations for several years. It was the selected remedy for the first Record of Decision (ROD) to be signed under the Superfund Amendments and Reauthorization Act of 1986 (the Verona Well Field Superfund Site in Battle Creek, Michigan). SVE has been chosen as a component of the ROD at over 30 Superfund sites [2] [3] [4] [5] [6].

Site-specific treatability studies are the only means of documenting the applicability and performance of an SVE system. The EPA Contact indicated at the end of this bulletin can assist in the location of other contacts and sources of information necessary for such treatability studies.

The final determination of the lowest cost alternative will be more site-specific than process equipment dominated. This bulletin provides information on the technology applicability, the limitations of the technology, the technology description, the types of residuals produced, site requirements, the latest performance data, the status of the technology, and sources for further information.

Technology Applicability

In situ SVE has been demonstrated effective for removing volatile organic compounds (VOCs) from the vadose zone. The effective removal of a chemical at a particular site does not, however, guarantee an acceptable removal level at all sites. The technology is very site-specific. It must be applied only after the site has been characterized. In general, the process works best in well drained soils with low organic carbon content. However, the technology has been shown to work in finer, wetter soils (e.g., clays), but at much slower removal rates [7, p. 5].

The extent to which VOCs are dispersed in the soil—vertically and horizontally—is an important consideration in deciding whether SVE is preferable to other methods. Soil excavation and treatment may be more cost effective when only a few hundred cubic yards of near-surface soils have been contaminated. If volume is in excess of 500 cubic yards, if the spill has penetrated more than 20 or 30 feet, or the contamination has spread through an area of several hundred square feet at a particular depth, then excavation costs begin to exceed those associated with an SVE system [8] [9] [10, p. 6].

The depth to groundwater is also important. Groundwater level in some cases may be lowered to increase the volume of the unsaturated zone. The water infiltration rate can be

* [reference number, page number]

Table 1
Effectiveness of SVE on General Contaminant Groups For Soil

	Contaminant Groups	Effectiveness Soil
Organic	Halogenated volatiles	■
	Halogenated semivolatiles	▼
	Nonhalogenated volatiles	■
	Nonhalogenated semivolatiles	■
	PCBs	❑
	Pesticides	❑
	Dioxins/Furans	❑
	Organic cyanides	❑
	Organic corrosives	❑
Inorganic	Volatile metals	❑
	Nonvolatile metals	❑
	Asbestos	❑
	Radioactive materials	❑
	Inorganic corrosives	❑
	Inorganic cyanides	❑
Reactive	Oxidizers	❑
	Reducers	▼

■ Demonstrated Effectiveness: Successful treatability test at some scale completed
▼ Potential Effectiveness: Expert opinion that technology will work
❑ No Expected Effectiveness: Expert opinion that technology will not work

controlled by placing an impermeable cap over the site. Soil heterogeneities influence air movement as well as the location of chemicals. The presence of heterogeneities may make it more difficult to position extraction and inlet wells. There generally will be significant differences in the air permeability of the various soil strata which will affect the optimum design of the SVE facility. The location of the contaminant on a property and the type and extent of development in the vicinity of the contamination may favor the installation of an SVE system. For example, if the contamination exists beneath a building or beneath an extensive utility trench network, SVE should be considered.

SVE can be used alone or in combination with other technologies to treat a site. SVE, in combination with groundwater pumping and air stripping, is necessary when contamination has reached an aquifer. When the contamination has not penetrated into the zone of saturation (i.e., below the water table), it is not necessary to install a groundwater pumping system. A vacuum extraction well will cause the water table to rise and will saturate the soil in the area of the contamination. Pumping is then required to draw the water table down and allow efficient vapor venting [11, p.169].

SVE may be used at sites not requiring complete remediation. For example, a site may contain VOCs and nonvolatile contaminants. A treatment requiring excavation might be selected for the nonvolatile contaminants. If the site required excavation in an enclosure to protect a nearby populace from VOC emissions, it would be cost effective to extract the volatiles from the soil before excavation. This would obviate the need for the enclosure. In this case it would be necessary to vent the soil for only a fraction of the time required for complete remediation.

Performance data presented in this bulletin should not be considered directly applicable to other Superfund sites. A number of variables such as the specific mix and distribution of contaminants affect system performance. A thorough characterization of the site and a well-designed and conducted treatability study are highly recommended.

The effectiveness of SVE on general contaminant groups for soils is shown in Table 1. Examples of constituents within contaminant groups are provided in the "Technology Screening Guide For Treatment of CERCLA Soils and Sludges" [12]. This table is based on the current available information or professional judgment where no information was available. The proven effectiveness of the technology for a particular site or waste does not ensure that it will be effective at all sites or that the treatment efficiencies achieved will be acceptable at other sites. For the ratings used in this table, demonstrated effectiveness means that, at some scale, treatability tests showed that the technology was effective for that particular contaminant and matrix. The ratings of potential effectiveness, or no expected effectiveness are both based upon expert judgment. Where potential effectiveness is indicated, the technology is believed capable of successfully treating the contaminant group in a particular matrix. When the technology is not applicable or will probably not work for a particular combination of contaminant group and matrix, a no-expected-effectiveness rating is given. Another source of general observations and average removal efficiencies for different treatability groups is contained in the Superfund Land Disposal Restrictions (LDR) Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions," (OSWER Directive 9347.3-06FS, July 1989) [13] and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions," (OSWER Directive 9347.3-07FS, December 1989) [14].

Limitations

Soils exhibiting low air permeability are more difficult to treat with in situ SVE. Soils with a high organic carbon content have a high sorption capacity for VOCs and are more difficult to remediate successfully with SVE. Low soil temperature lowers a contaminant's vapor pressure, making volatilization more difficult [11].

Sites that contain a high degree of soil heterogeneity will likely offer variable flow and desorption performance, which will make remediation difficult. However, proper design of the vacuum extraction system may overcome the problems of heterogeneity [7, p. 19] [15].

It would be difficult to remove soil contaminants with low vapor pressures and/or high water solubilities from a site. The lower limit of vapor pressure for effective removal of a compound is 1 mm Hg abs. Compounds with high water solubilities, such as acetone, may be removed with relative ease from arid soils. However, with normal soils (i.e., moisture content ranging from 10 percent to 20 percent), the likelihood of successful remediation drops significantly because the moisture in the soil acts as a sink for the soluble acetone.

Technology Description

Figure 1 is a general schematic of the in situ SVE process. After the contaminated area is defined, extraction wells (1) are installed. Extraction well placement is critical. Locations must be chosen to ensure adequate vapor flow through the contaminated zone while minimizing vapor flow through other zones [11, p. 170]. Wells are typically constructed of PVC pipe that is screened through the zone of contamination [11]. The screened pipe is placed in a permeable packing; the unscreened portion is sealed in a cement/bentonite grout to prevent a short-circuited air flow direct to the surface. Some SVE systems are installed with air injection wells. These wells may either passively take in atmospheric air or actively use forced air injection [9]. The system must be designed so that any air injected into the system does not result in the escape of VOCs to the atmosphere. Proper design of the system can also prevent offsite contamination from entering the area being extracted.

The physical dimensions of a particular site may modify SVE design. If the vadose zone depth is less than 10 feet and the area of the site is quite large, a horizontal piping system or trenches may be more economical than conventional wells.

An induced air flow draws contaminated vapors and entrained water from the extraction wells through headers—usually plastic piping—to a vapor-liquid separator (2). There, entrained water is separated and contained for subsequent treatment (4). The contaminant vapors are moved by a vacuum blower (3) to vapor treatment (5).

Vapors produced by the process are typically treated by carbon adsorption or thermal destruction. Other methods—such as condensation, biological degradation, and ultraviolet oxidation—have been applied, but only to a limited extent.

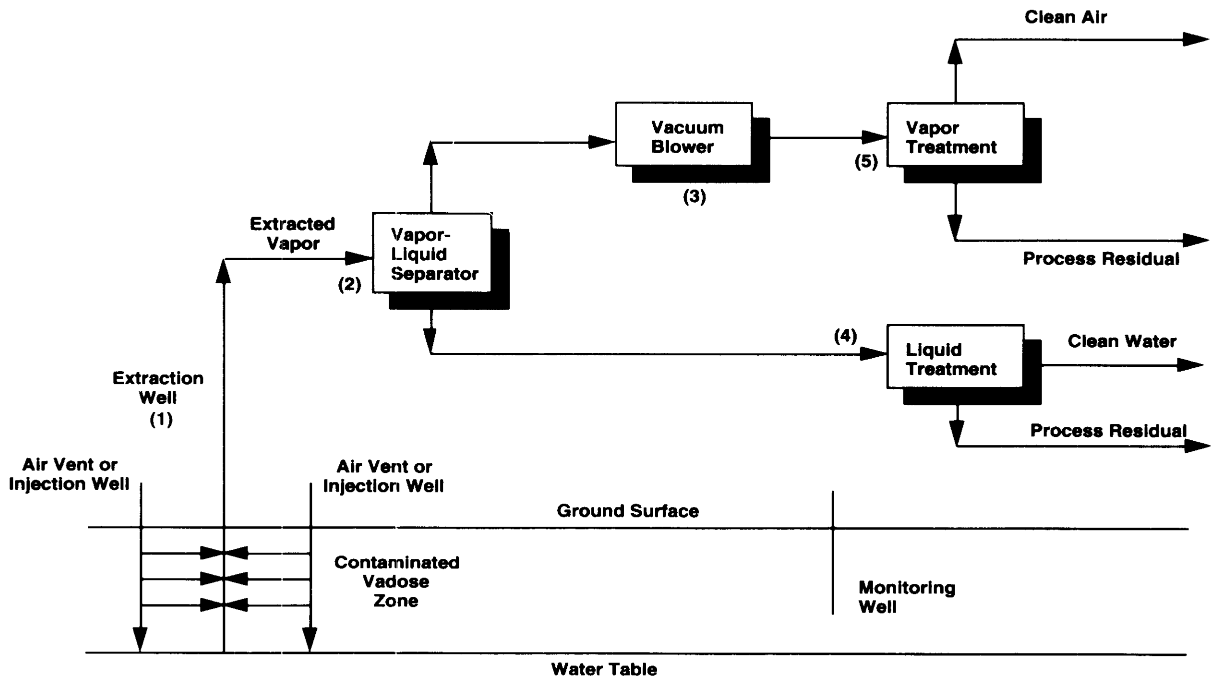
Process Residuals

The waste streams generated by in situ SVE are vapor and liquid treatment residuals (e.g., spent granular activated carbon [GAC]), contaminated groundwater, and soil tailings from drilling the wells. Contaminated groundwater may be treated and discharged onsite [12, p. 86] or collected and treated offsite. Highly contaminated soil tailings from drilling must be collected and may be either cleaned onsite or sent to an offsite, permitted facility for treatment by another technology such as incineration.

Site Requirements

SVE systems vary in size and complexity depending on the capacity of the system and the requirements for vapor and liquid treatment. They are typically transported by vehicles ranging from trucks to specifically adapted flatbed semitrailers; therefore, a proper staging area for these vehicles must be incorporated in the plans.

Figure 1
Process Schematic of the In Situ Soil Vapor Extraction System



Adequate access roads must be provided to bring mobile drilling rigs onsite for construction of wells and to deliver equipment required for the process (e.g., vacuum blowers, vapor-liquid separator, emission control devices, GAC canisters).

A small commercial-size SVE system would require about 1,000 square feet of ground area for the equipment. This area does not include space for the monitoring wells which might cover 500 square feet. Space may be needed for a forklift truck to exchange skid-mounted GAC canisters when regeneration is required. Large systems with integrated vapor and liquid treatment systems will need additional area based on vendor-specific requirements.

Standard 440V, three-phase electrical service is needed. For many SVE applications, water may be required at the site. The quantity of water needed is vendor- and site-specific.

Contaminated soils or other waste materials are hazardous, and their handling requires that a site safety plan be developed to provide for personnel protection and special handling measures. Storage should be provided to hold the process product streams until they have been tested to determine their acceptability for disposal or release. Depending upon the site, a method to store soil tailings from drilling operations may be necessary. Storage capacity will depend on waste volume.

Onsite analytical equipment, including gas chromatographs and organic vapor analyzers capable of determining site-specific organic compounds for performance assessment, make the operation more efficient and provide better information for process control.

Performance Data

SVE, as an in situ process (no excavation is involved), may require treatment of the soil to various cleanup levels mandated by federal and state site-specific criteria. The time required to meet a target cleanup level (or performance objective) may be estimated by using data obtained from bench-scale and pilot-scale tests in a time-predicting mathematical model. Mathematical models can estimate cleanup time to reach a target level, residual contaminant levels after a given period of operation and can predict location of hot spots through diagrams of contaminant distribution [16].

Table 2 shows the performance of typical SVE applications. It lists the site location and size, the contaminants and quantity of contaminants removed, the duration of operation, and the maximum soil contaminant concentrations before treatment and after treatment. The data presented for specific contaminant removal effectiveness were obtained, for the most part, from publications developed by the respective SVE system vendors. The quality of this information has not been determined.

Midwest Water Resources, Inc. (MWRI) installed its VAPORTECH™ pumping unit at the Dayton, Ohio site of a spill of uncombusted paint solvents caused by a fire in a paint warehouse [19]. The major VOC compounds identified were acetone, methyl isobutyl ketone (MIBK), methyl ethyl ketone (MEK), benzene, ethylbenzene, toluene, naphtha, xylene, and other volatile aliphatic and alkyl benzene compounds. The site is underlain predominantly by valley-fill glacial outwash within the Great Miami River Valley, reaching a thickness of over 200 feet. The outwash is composed chiefly of coarse, clean sand and gravel, with numerous cobbles and small boulders. There are two outwash units at the site separated by a discontinuous till at depths of 65 to 75 feet. The upper outwash forms an unconfined aquifer with saturation at a depth of 45 to 50 feet below grade. The till below serves as an aquitard between the upper unconfined aquifer and the lower confined to semiconfined aquifer. Vacuum withdrawal extended to the depth of groundwater at about 40 to 45 feet. During the first 73 days of operation, the system yielded 3,720 pounds of volatiles and after 56 weeks of operation, had recovered over 8,000 pounds of VOCs from the site. Closure levels for the site were developed for groundwater VOC levels of ketones only. These soil action levels (acetone, 810 µg/l; MIBK, 260 µg/l, and MEK, 450 µg/l) were set so that waters recharging through contaminated soils would result in

Table 2.
Summary of Performance Data for In Situ Soil Vapor Extraction

Site	Size	Contaminants	Quantity removed	Duration of operation	Soil concentrations (mg/kg) max. before treatment	after treatment
Industrial - CA [17]	--	TCE	30 kg	440 days	0.53	0.06
Sheet Metal Plant - MI [18]	5,000 cu yds	PCE*	59 kg	35 days	5600	0.70
Prison Const. Site - MI [19]	165,000 cu yds	TCA	--	90 days	3.7	0.01
Sherwin-Williams Site - OH [19]	425,000 cu yds	Paint solvents	4,100 kg	6 mo	38	0.04
Upjohn - PR [20][21]	7,000,000 cu yds	CCl_4	107,000 kg	3 yr	2200	<0.005
UST Bellview - FL [7]	--	BTEX	9,700 kg	7 mo	97	<0.006
Verona Wellfield - MI [7][22]	35,000 cu yds	TCE, PCE, TCA	12,700 kg	Over 1 yr	1380	Ongoing
Petroleum Terminal - Owensboro, KY [19]	12,000 cu yds	Gasoline, diesel	--	6 mo	>5000	1.0 (target)
SITE Program - Groveland MA [7]	6,000 cu yds	TCE	590 kg	56 days	96.1	4.19

*PCE = Perchloroethylene

groundwater VOC concentrations at or below regulatory standards. The site met all the closure criteria by June 1988.

A limited amount of performance data is available from Superfund sites. The EPA Superfund Innovative Technology Evaluation (SITE) Program's Groveland, Massachusetts, demonstration of the Terra Vac Corporation SVE process produced data that were subjected to quality assurance/quality control tests. These data appear in Table 2 [7, p. 29] and Table 3 [7, p. 31]. The site is contaminated by trichloroethylene (TCE), a degreasing compound which was used by a machine shop that is still in operation. The subsurface profile in the test area consists of medium sand and gravel just below the surface, underlain by finer and silty sands, a clay layer 3 to 7 feet in depth, and—below the clay layer—coarser sands with gravel. The clay layer or lens acts as a barrier against gross infiltration of VOCs into subsequent subsoil strata. Most of the subsurface contamination lay above the clay lens, with the highest concentrations adjacent to it. The SITE data represent the highest percentage of contaminant reduction from one of the four extraction wells installed for this demonstration test. The TCE concentration levels are weighted average soil concentrations obtained by averaging split spoon sample concentrations every 2 feet over the entire 24-foot extraction well depth. Table 3 shows the reduction of TCE in the soil strata near the same extraction well. The Groveland Superfund Site is in the process of being remediated using this technology [2].

The Upjohn facility in Barceloneta, Puerto Rico, is the first and, thus far, the only Superfund site to be remediated with SVE. The contaminant removed from this site was a mixture containing 65 percent carbon tetrachloride (CCl_4) and 35 percent acetonitrile [20]. Nearly 18,000 gallons of CCl_4 were extracted during the remediation, including 8,000 gallons that were extracted during a pilot operation conducted from January 1983 to April 1984. The volume of soil treated at the Upjohn site amounted to 7,000,000 cubic yards. The responsible party originally argued that the site should be considered clean when soil samples taken from four boreholes drilled in the area of high pretest contamination show nondetectable levels of CCl_4. EPA did not accept this criterion but instead required a cleanup criteria of nondetectable levels of CCl_4 in all the exhaust stacks for 3 consecutive months [21]. This requirement was met by the technology and the site was considered remediated by EPA.

Approximately 92,000 pounds of contaminants have been recovered from the Tyson's Dump site (Region 3) between November 1988 and July 1990. The site consists of two unlined lagoons and surrounding areas formerly used to store chemical wastes. The initial Remedial Investigation identified no soil heterogeneities and indicated that the water table was 20 feet below the surface. The maximum concentration in the soil (total VOCs) was approximately 4 percent. The occurence of dense nonaqueous-phase liquids (DNAPLs) was limited in areal extent. After over 18 months of operation, a number of difficulties have been encountered. Heterogeneities in soil grain size, water content, permeability, physical structure and compaction, and in contaminant concentrations have been identified. Soil contaminant concentrations of up to 20 percent and widespread distribution of DNAPLs have been found. A tar-like substance, which has caused plugging, has been found in most of the extraction wells. After 18 months of operation, wellhead concentrations of total VOCs have decreased by greater than 90 percent [23, p. 28].

As of December 31, 1990, approximately 45,000 pounds of VOCs had been removed from the Thomas Solvent Raymond Road Operable Unit at the Verona Well Field site (Region 5). A pilot-scale system was tested in the fall of 1987 and a full-scale operation began in March, 1988. The soil at the site consists of poorly-graded, fine-to-medium-grained loamy soils underlain by approximately 100 feet of sandstone. Groundwater is located 16 to 25 feet below the surface. Total VOC concentrations in the combined extraction well header have decreased from a high of 19,000 ug/1 in 1987 to approximately 1,500 ug/1 in 1990 [22].

Table 3
Extraction Well 4: TCE Reduction In Soil Strata—EPA Site Demonstration (Groveland, MA) [7, p. 31]

Depth (ft)	Description of strata	Hydraulic Conductivity (cm/s)	Soil TCE concentration (mg/kg) Pre-treatment	Post-treatment
0-2	Med. sand w/gravel	10^{-4}	2.94	ND
2-4	Lt. brown fine sand	10^{-4}	29.90	ND
4-6	Med. stiff lt. brown fine sand	10^{-5}	260.0	39.0
6-8	Soft dk. brown fine sand	10^{-5}	303.0	9.0
8-10	Med. stiff brown sand	10^{-4}	351.0	ND
10-12	V. stff lt. brown med. sand	10^{-4}	195.0	ND
12-14	V. Stiff brown fine sand w/silt	10^{-4}	3.14	2.3
14-16	M. stff grn-brn clay w/silt	10^{-8}	ND	ND
16-18	Soft wet clay	10^{-8}	ND	ND
18-20	Soft wet clay	10^{-8}	ND	ND
20-22	V. stiff brn med-coarse sand	10^{-4}	ND	ND
22-24	V. stiff brn med-coarse w/gravel	10^{-3}	6.17	ND

ND - Nondetectable level

An SVE pilot study has been completed at the Colorado Avenue Subsite of the Hastings (Nebraska) Groundwater Contamination site (Region 7). Trichloroethylene (TCE), 1,1,1-trichloroethane (TCA), and tetrachloroethylene (PCE) occur in two distinct unsaturated soil zones. The shallow zone, from the surface to a depth of 50 to 60 feet, consists of sandy and clayey silt. TCE concentrations as high as 3,600 ug/1 were reported by EPA in this soil zone. The deeper zone consists of interbedded sands, silty sands, and gravelly sands extending from about 50 feet to 120 feet. During the first 630 hours of the pilot study (completed October 11, 1989), removal of approximately 1,488 pounds of VOCs from a deep zone extraction well and approximately 127 pounds of VOCs from a shallow zone extraction well were reported. The data suggest that SVE is a viable remedial technology for both soil zones [24].

As of November, 1989, the SVE system at the Fairchild Semi-conductor Corporation's former San Jose site (Region 9) has reportedly removed over 14,000 pounds of volatile contaminants. Total contaminant mass removal rates for the SVE system fell below 10 pounds per day on October 5, 1989 and fell below 6 pounds per day in December, 1989. At that time, a proposal to terminate operation of the SVE system was submitted to the Regional Water Quality Control Board for the San Francisco Bay Region [25, p.3].

Resource Conservation and Recovery Act (RCRA) LDRs that require treatment of wastes to best demonstrated available technology (BDAT) levels prior to land disposal may sometimes be determined to be applicable or relevant and appropriate requirements for CERCLA response actions. SVE can produce a treated waste that meets treatment levels set by BDAT but may not reach these treatment levels in all cases. The ability to meet required treatment levels is dependent upon the specific waste constituents and the waste matrix. In cases where SVE does not meet these levels, it still may, in certain situations, be selected for use at the site if a treatability variance establishing alternative treatment levels is obtained. EPA has made the treatability variance process available in order to ensure that LDRs do not unnecessarily restrict use of alternative and innovative treatment technologies. Treatability variances are justified for handling complex soil and debris matrices. The following guides describe when and how to seek a treatability variance for soil and debris: Superfund LDR Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions" (OSWER Directive 9347.3-06FS, July 1989) [13], and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions" (OSWER Directive 9347.3-07FS, December 1989) [14]. Another approach could be to use other treatment techniques in series with SVE to obtain desired treatment levels.

Technology Status

During 1989, at least 17 RODs specified SVE as part of the remedial action [5]. Since 1982, SVE has been selected as the remedial action, either alone or in conjunction with other treatment technologies, in more than 30 RODs for Superfund sites [2] [3] [4] [5] [6]. Table 4 presents the location, primary contaminants, and status for these sites [3] [4] [5]. The technology also has been used to clean up numerous underground gasoline storage tank spills.

A number of variations of the SVE system have been investigated at Superfund sites. At the Tinkhams Garage Site in New Hampshire (Region 1), a pilot study indicated that SVE, when used in conjunction with ground water pumping (dual extraction), was capable of treating soils to the 1 ppm clean-up goal [26, 3-7] [27]. Soil dewatering studies have been conducted to determine the feasability of lowering the water table to permit the use of SVE at the Bendix, PA Site (Region 3) [28]. Plans are underway to remediate a stockpile of 700 cubic yards of excavated soil at the Sodeyco Site in Mt. Holly, NC using SVE [29].

With the exception of the Barceloneta site, no Superfund site has yet been cleaned up to the performance objective of the technology. The performance objective is a site-specific contaminant concentration, usually in soil. This objective may be calculated with mathematical models with which EPA evaluates delisting petitions for wastes contaminated with VOCs [30]. It also may be possible to use a TCLP test on the treated soil with a corresponding drinking water standard contaminant level on the leachate.

Most of the hardware components of SVE are available off the shelf and represent no significant problems of availability. The configuration, layout, operation, and design of the extraction and monitoring wells and process components are site specific. Modifications may also be required as dictated by actual operating conditions.

On-line availability of the full-scale systems described in this bulletin is not documented. System components are highly reliable and are capable of continuous operation for the duration of the cleanup. The system can be shut down, if necessary, so that component failure can be identified and replacemnts made quickly for minimal downtime.

Based on available data, SVE treatment estimates are typically $50/ton for treatment of soil. Costs range from as low as $10/ton to as much as $150/ton [7]. Capital costs for SVE consist of extraction and monitoring well construction; vacuum blowers (positive displacement or centrifugal); vapor and liquid treatment systems piping, valves, and fittings (usually plastic); and instrumentation [31]. Operations and maintenance costs include labor, power, maintenance, and monitoring activities. Offgas and collected groundwater treatment are the largest cost items in this list; the cost of a cleanup can double if both are treated with activated carbon. Electric power costs vary by location (i.e., local utility rates and site conditions). They may be as low as 1 percent or as high as 2 percent of the total project cost.

Caution is recommended in using these costs out of context, because the base year of the estimates vary. Costs also are highly variable due to site variations as well as soil and contaminant characteristics that impact the SVE process. As contaminant concentrations are reduced, the cost effectiveness of an SVE system may decrease with time.

Table 4
Superfund Sites Specifying SVE as a Remedial Action

Site	*Location (Region)*	*Primary Contaminants*	*Status*	
Groveland Wells 1 & 2	Groveland, MA (1)	TCE	SITE demonstration complete Full-scale Remediation in design	[2][7]
Kellogg-Deering Well Field	Norwalk, CT (1)	PCE, TCE, and BTX	Pre-design	[3] [5] [6]
South Municipal Water Supply Well	Peterborough, NH (1)	PCE, TCE, Toluene	Pre-design completion expected in the fall of 1991	[3] [5][6]
Tinkham Garage	Londonderry, NH (1)	PCE, TCE	Pre-design pilot study completed	[26] [27]
Wells G & H	Woburn, MA (1)	PCE, TCE	In design	[3] [5]
FAA Technical Center	Atlantic County, NJ (2)	BTX, PAHs, Phenols	In design	[3] [5]
Upjohn Manufacturing Co.	Barceloneta, PR (2)	CCl_4	Project completed in 1988	[20] [21]
Allied Signal Aerospace-Bendix Flight System Div.	South Montrose, PA (3)	TCE	Pre-design tests and dewatering study completed	[28]
Henderson Road	Upper Merion Township, PA (3)	PCE, TCE, Toluene, Benzene	Pre-design	[3] [4]
Tyson's Dump	Upper Merion Township, PA (3)	PCE, TCE, Toluene, Benzene, Trichloropropane	In operation (since 11/88)	[23]
Stauffer Chemical	Cold Creek, AL (4)	CCL_4, pesticides	Pre-design	[5] [6]
Stauffer Chemical	Lemoyne, AL (4)	CCL_4, pesticides	Pre-design	[5] [6]
Sodyeco	Mt. Holly, NC (4)	TCE, PAHs	Design approved	[29]
Kysor Industrial	Cadillac, MI (5)	PCE, TCE,Toluene, Xylene	In design; pilot studies in progress	[3] [5] [6]
Long Prairie	Long Prairie, MN (5)	PCE, TCE, DCE, Vinyl chloride	SVE construction expected in the Fall of 1991	[3] [6]
MIDCO 1	Gary, IN (5)	BTX, TCE, Phenol, Dichloromethane, 2-Butanone, Chlorobenzene	In Design	[3] [5] [6]
Miami County Incinerator	Troy, OH (5)	PCE; TCE; Toluene	Pre-design	[3] [5] [6]
Pristine	Cincinnati, OH (5)	Benzene; Chloroform; TCE; 1,2-DCA; 1,2-DCE	Pre-design	[3] [6]
Seymour Recycling	Seymour, IN (5)	TCE; Toluene; Chloromethane; cis-1, 2-DCE; 1,1,1-DCA; Chloroform	Pre-design investigation completed	[32]
Verona Well Field	Battle Creek, MI (5)	PCE, TCA	Operational since 3/81	[22]
Wausau Groundwater Contamination	Wausau, WI (5)	PCE, TCE	Pre-design	[3] [5] [6]
South Valley/ General Electric	Albuquerque, NM (6)	Chlorinated solvents	Pilot studies scheduled for Summer of 1991	[4] [6]
Hastings Groundwater Contamination	Hastings, NE (7)	CCL_4 ,Chloroform	Pilot studies completed for Colorado Ave. & Far-Marco subsites	[24]
Sand Creek Industrial	Commerce City, CO (8)	PCE, TCE, pesticides	Pilot study completed	[33]
Fairchild Semiconductor	San Jose, CA (9)	PCE, TCA, DCE, DCA, Vinyl chlorides, Phenols, and Freon	Operational since 1988, Currently conducting resaturation studies	[25]
Fairchild Semiconductor/ MTV-1	Mountain View, CA (9)	PCE, TCA, DCE, DCA, Vinyl chlorides, Phenols, and Freon	Pre-design	[3] [5]
Fairchild Semiconductor/ MTV-2	Mountain View, CA (9)	PCE, TCA, DCE, DCA, Vinyl chlorides, Phenols, and Freon	Pre-design	[3] [5]
Intel Corporation	Mountain View, CA (9)	PCE, TCA, DCE, DCA, Vinyl chlorides, Phenols, and Freon	Pre-design	[3] [5]
Raytheon Corporation	Mountain View, CA (9)	PCE, TCA, DCE, DCA, Vinyl chlorides, Phenols, and Freon	Pre-design	[3] [5]
Motorola 52nd Street	Phoenix, AZ (9)	TCA, TCE, CCL_4, Ethylbenzene	Pre-design	[3] [4] [6]
Phoenix-Goodyear Airport Area (also Litchfield Airport Area)	Goodyear, AZ (9)	TCE, DCE, MEK	North Unit - In design South Unit - pilot study completed	[34]

EPA Contact

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